

Flipping for Active Learning:
Analysis of a High School Flipped Classroom with Active Learning

Abby Cunningham
Iowa State University
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Introduction

Student achievement in math has long been a topic of conversation. According to the National Assessment of Educational Progress, student achievement in math steadily increased

from 1990 to 2003 but since then, has only slightly increased and, most recently, saw a slight decline in 2015 (NAEP, 2015). Most educators have tried various interventions to improve student achievement in math, including flipping their classroom, which can maximize the quality of face-to-face time and allow for more active learning experiences. Evidence shows that there is a direct correlation to students engaging in active learning in the classroom and student achievement (Wiginton, 2013).

Even with the surge of technological advances in the most recent years, many secondary classrooms still look as they did thirty years ago. An instructor stands at the front of the room and lectures students while they passively take notes. A call for more engaging and active learning experiences for students has brought about such strategies such as problem based learning, project based learning, online courses, blended courses and the flipped classroom, to name a few.

There has been little research conducted that explores the impact of a flipped classroom on student achievement over a long period of time. Changes in available technology allow an instructor to constantly fine-tune this learning environment in order to reach it's maximum potential.

To examine the effectiveness of the flipped classroom on student achievement the researcher collected test score data from three years prior to implementing the flipped classroom as well as the two years after implementing the flipped classroom. The second year of the flipped classroom involved active learning in the form of group work. During the course of this study, the researcher fine-tuned and increased active learning strategies over Unit 10: Formulas for Surface Area and Volume. The data collected allowed the researcher to compare student

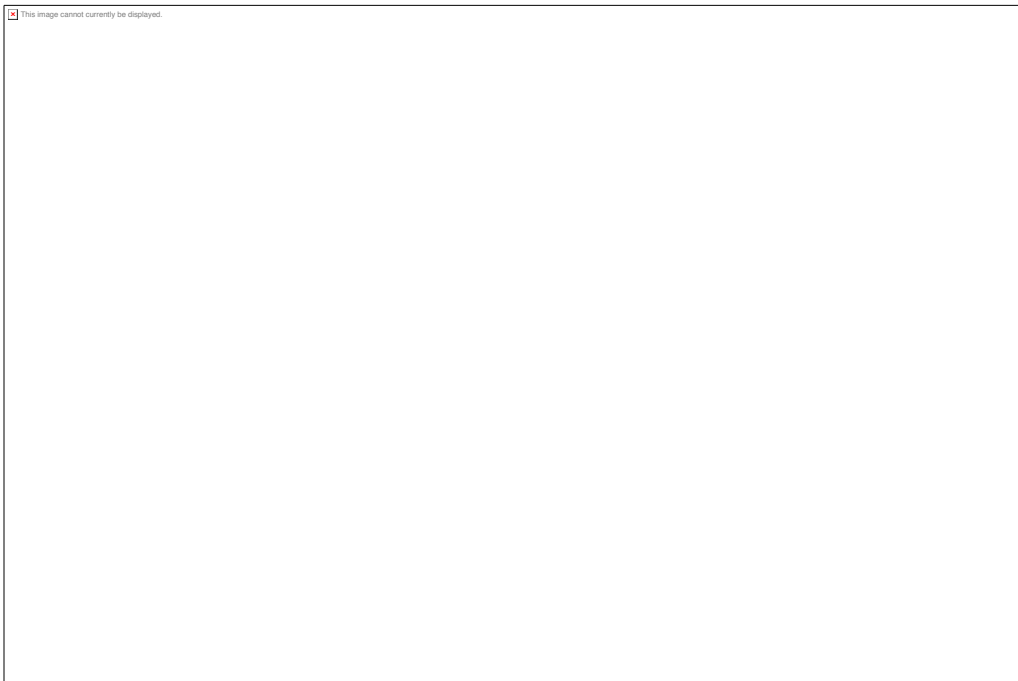
performance on four units of study as well as student performance on specific learning objectives (learning targets) within each unit of study over the course of the five year period.

The active learning strategies included group collaboration on homework as well as game based strategies in which students competed to achieve a high score by collaborating with other students to solve high level math problems. Students were then asked to complete a survey about their perceptions of the flipped classroom and their impressions of the active learning work.

The action research model used in this study is Riel's Action Research Model. The

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Figure 1



Riel's Action Research Model. Adapted from *Wikimedia*, by M. Riel, 2006, Retrieved from https://commons.wikimedia.org/wiki/File:Riel-action_research.jpg#file. Creative Commons Attribution-

The first step of Cycle 1 of Riel's model, Study and Plan, took place over the course of the first three years of traditional teaching. It was the perception of the instructor that many students were not fully engaged in the course. Many students either passively engaged in class by taking notes during the lecture or did not pay attention to the lecture. Students either used outside resources to learn the material or did just enough to get by. Since this course allows students to reassess, it was noted that many students relied heavily on these reassessments in order to achieve the grade they wanted.

In the spring of 2014, the instructor studied the flipped classroom and decided to utilize the model in the fall of that same year. Students were required to watch a tutorial video of the lesson at home then, in class, students heard a mini-lesson from the instructor and worked on the same problem sets, tests, and quizzes as in previous years. Students were allowed to collaborate on these assignments and were given checkpoints along the way to ensure they were on track for the test. According to the perceptions of the instructor, as the course went on, the level of engagement increased and then started to decrease.

In the summer of 2015 the researcher studied more techniques of a successful flipped classroom and chose to utilize group work to increase engagement. Students were still assigned the same problem sets and given the same tests and quizzes as in previous years but each problem set was split into two separate assignments, group work and individual work. Again, according to the instructor, the level of engagement seemed to increase but then decreased as time went on.

During the spring of 2016 the researcher studied the formal literature of a flipped classroom as evidenced in the literature review section of this paper. Through this review the researcher noted that true active learning opportunities were lacking in the instructor's current

model of the flipped classroom. The researcher conducted and analyzed test score data over a five year period and took a deeper look at the data after active learning strategies were utilized.

Analysis and interpretation of the data is reported in the findings section of this paper. An action plan as to how the flipped classroom can be implemented by other educators and suggestions for implementing a flipped classroom in the future are also included. The next section of this paper will describe the area of focus statement, the objectives, and how they were developed in further detail.

Area of Focus Statement

The purpose of this action research study is to describe the effects of using a flipped classroom instructional approach on ninth grade student achievement in Advanced Geometry. Research studies investigating the impact of a flipped classroom on student learning are lacking, especially in the context of a high school classroom over time. This study examined whether or not using the flipped classroom approach to learning impacts student achievement in Advanced Geometry, whether or not using the flipped classroom approach with active learning strategies impacts student achievement in Advanced Geometry, and student perceptions on the flipped classroom. Research questions addressed in this study are stated in the following section.

Research Questions

What are the effects of a flipped classroom on 9th grade students' achievement in Advanced Geometry?

- How will implementing a flipped classroom approach impact overall student test scores on Advanced Geometry concepts?
- How does a flipped classroom, combined with active learning strategies, impact student test scores on Advanced Geometry concepts?

- What are student perceptions of the flipped classroom?

Literature Review

This literature review focuses on various other studies conducted by educators who have implemented a flipped classroom, both in a secondary setting as well as a higher education setting. The implementation of a flipped classroom is unique to each teacher and each setting; however, there are some similar characteristics that have been identified for the implementation of successful flipped classrooms. Thus, this literature review focuses on trends within a flipped classroom, mainly active learning strategies. Literature reviewed also compares a traditional classroom to a flipped classroom and analyzes student academic achievement results as well as student perceptions of a flipped classroom. First, a flipped classroom is defined.

The Flipped Classroom

The governing board and key leaders of the Flipped Learning Network have defined flipped learning in order to counter some common misconceptions about it:

Flipped learning is a pedagogical approach in which the direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter. (Flipped Learning Network, 2014, column 2 ¶1)

Flipped instruction fits into the category of blended instruction in which the most effective components traditional face-to-face are combined with the most effective components of distance learning (Wiginton, 2013). Variations of the flipped classroom can be seen in the

lower elementary levels but the flipped classroom approach seems to cater to the secondary and higher education levels. Next, the historical context is explained.

Historical Context

Two different groups of educators are credited with the idea of the flipped classroom: two high school science teachers, Jon Bergmann and Aaron Sams, and Salmon Khan, creator of Khan Academy. In 2007, Jonathan Bergman and Aaron Sams began recording and posting their lessons on YouTube as a means to support their athletes who regularly missed school. Some students who did not miss the live lecture ended up watching the videos as a way to review for an exam. In no time, students and teachers from all over the world began watching the videos and using them to learn. Sams noticed that the time when students really needed him was when they got stuck on an assignment and needed individual help. He argued that the students did not need him to deliver the content, they needed him to be there when they needed the individual assistance (Bergmann & Sams, 2012).

In 2004 Salmon Khan, creator of Khan Academy (Adams, 2013), started remotely tutoring his cousin in math. Soon Khan started recording his tutoring sessions and making them available on YouTube so other relatives could access them. People from all over the country took notice and in 2009 Khan launched Khan Academy, a free tutoring, mentoring, and testing online website (<https://www.khanacademy.org>). Using Khan Academy videos students can work at their own pace through the videos and online exercises, earning points and badges as they go.

The initial idea behind both groups was the same: provide educational resources in the form of videos for use outside of the classroom (Adams, 2013; Bergmann & Sams, 2012) but Bergman and Sams now focus their efforts on educating teachers and Khan develops content for student use. Bergman and Sams have written a number of books on the subject and have created

The Flipped Learning Network, “a nonprofit organization which provides teachers with the resources needed to implement flipped learning” (Sams, Bergmann, Daniels, Bennett, Marshall, & Arfstrom, 2014). Salmon Khan’s idea is to go directly to the students to “provide a free, world-class education for anyone, anywhere (Khan Academy, 2016).” Today some teachers utilize the Khan Academy videos in order to flip their classrooms. Active learning is defined in the next section.

Active Learning

Active learning means students must be actively involved and engaged in higher-order thinking tasks such as analysis, synthesis, and evaluation. Creating active learning opportunities for students can be as simple as integrating in-class activities alongside traditional lecture (Roehl, Reddy & Shannon, 2013).

The greatest thing the flipped classroom provides is more time. Students have more opportunities for advanced preparation and teachers have more time to identify knowledge gaps needing clarification (Hawks, 2014). Although most flipped classrooms provide video lectures for students to gain their initial knowledge, a few offer a level of choice to gain exposure to new content which includes not only video lectures but text readings, interactive learning modules, at-home quizzes, and powerpoint presentations. During the scheduled class time, students spend their time doing hands-on activities, working problem sets, problem based learning, project based learning, small group work, self reflection, debates, and classroom discussions - all things that are considered active learning and require students to engage in higher-order thinking (Roehl, Reddy & Shannon, 2013).

Figure 2 is an example of what a flipped classroom might look like. One particularly interesting thing to note in this model is that eighty percent of what students learned outside of

the classroom is foundational material and only twenty percent is complex concepts and applications. One hundred percent of class time is then dedicated to application, activities and assessment. This is a common format for flipped classrooms.



Example of a Flipped Classroom Structure (McLaughlin, Roth, Glatt, Gharkholonarehe, Davidson, Griffin, & Munner, 2014)

When students engaged in these active learning strategies researchers saw significant learning gains as well as positive student reactions to the course structure. Students become active participants in their education (Mangan, 2013). Wiginton (2013) suggests that classroom teachers should utilize the flipped classroom in order to make more in-class time available for active learning strategies which can help teach students responsibility, self-regulation, and take ownership in the learning process. When employing active learning strategies, students apply their knowledge at the same time they are learning it, encouraging critical thinking skills and fostering self-directed learning (Toto & Nguyen, 2009). The next section will discuss the major differences between traditional and flipped classrooms.

Traditional versus Flipped Classrooms

In traditional classrooms, the instructor presents information relaying fact-based or procedural information to the students while they assume a passive role, typically writing notes on the lecture and occasionally asking questions. If time allows, some activities are included but are not part of the typical structure of the course. Students are moved through the course at the same pace regardless of whether or not they understand the material. At home, students are expected to apply the material they received in class to similar, but often more difficult problem sets. This creates frustration among many students which results in low homework completion.

The main purpose of a flipped class is to provide more active learning experiences for students. Researchers have repeatedly stated that the flipped design has greatly addressed some of the major issues of a traditional learning environment. In traditional style courses, students typically encounter the difficult and often frustrating content outside of class time while they are practicing what was presented in class. Instructors following a traditional approach to instruction often complain that making the content relevant is difficult, keeping students actively engaged in the learning process is challenging, and there is a significant lack of time necessary to engage in more active learning experiences (Wilson, 2013).

In addition to solving some of the traditional classroom problems, there are additional benefits of a flipped classroom. Instructors have the opportunity to move students through the content at their own pace which will alleviate some frustrations among those students who need a little extra time to learn. Since homework is typically done in the classroom, teachers gain insight on a daily basis as to where their students are struggling, as opposed to on a test or quiz when it may be too late. The technology used in a flipped classroom promotes a 21st Century learning environment. Also, teachers can customize and update their content easier and push it

out to students 24/7 and learning theory supports the flipped approach (Freeman & Schiller, 2012).

The flipped class seems to address and resolve many issues of a traditional classroom although it creates some issues as well. Students may be initially resistant because it requires a commitment that they get their initial instruction at home rather than in school. Consequently, they may come unprepared to class to participate in the active learning phase of the course (Wilson, 2013). This problem can be solved by giving a short quiz at the beginning of the class, doing a mini-lesson over the content that reveals the basic information, or by using computer programs that track student progress outside of class.

Another challenge associated with a flipped classroom is that teachers must carefully develop the pre-class content in a way that will prepare students for the active learning the next day (Wilson, 2013). This requires time that many teachers do not have. This problem can be addressed by using videos created by other people (i.e., Khan Academy) and slowly working their own videos into the rotation. Teachers can also partner with another teacher who teaches the same content in order to share the workload.

The benefits of the flipped class versus a traditional class may not be evident early in the course but should increase as the course progresses (Love, Hodge, Grandgenett, & Swift, 2013). One of the many observations about the flipped class in its initial stages is that student test scores tend to drop slightly or stay the same. It is speculated that students have been conditioned in the traditional model through repeated exposure to succeed in this type classroom and when those methods are changed an adjustment period is needed which results in a drop in test scores (Weltman, & Whiteside, 2010,). The results of implementing a flipped classroom are discussed in the next section.

Results of Implementing the Flipped Classroom

Studies on flipped classrooms typically focus on two types of research designs. First, instructors use a sample of the population by flipping their classroom for a specific unit of study (Brunsell, 2013), a few units of study (Fallis, 2013), or one semester (Love, Hodge, Grandgenett, & Swift, 2013), then report their findings. Second, researchers design the study using control and experimental groups in which they use two course sections and flip one of them, comparing the results (Love, 2013).

The majority of instructors see some sort of a gain in student test scores when the flipped classroom is implemented (Wiginton, 2013). One study, typical of others, compared a traditional and flipped class throughout the semester and researchers saw no significant differences among pre-test data but there was a significant difference in the post-test data favoring students in the flipped designed class (Wilson, 2013).

Although students are fairly skeptical about the flipped class initially, research indicates their attitudes significantly improve as the semester goes on (Wilson, 2013). The majority of students tend to see the benefits of a flipped classroom. They enjoy the flexibility of it, are more engaged in the content, have increased motivation, enjoy being able to communicate with both the teacher and other students on a daily basis, and enjoy the activities incorporated into the classroom (Berrett, 2013). Because the flipped classroom often requires students to take an active role in their learning, students often start to feel more comfortable working in groups or doing problem sets on the board in front of their peers. The culture of the classroom tends to change from students only worried about their individual learning to students concerned about the learning of others. Also, students report that they typically spend less time outside of class on the coursework (Berrett, 2013).

One of the most common themes surrounding student perceptions around flipped learning is their attitudes towards the instructional videos. Although students do not always enjoy the videos, they see the benefits of providing the lecture in a video format (Berrett, 2013). Students can pause, rewind, and rewatch the videos. They can also watch the videos at a time and place that suits their educational needs. They do not have to listen to a lecture in its entirety, they can pause it, take a break, then come back to it later, taking control of their learning at a pace that suits their individual learning style (Wiginton, 2013). The next section will sum up the major points in this literature review.

Summary

In sum, this review of the literature focused on trends within a flipped classroom, mainly active learning strategies. Literature reviewed also compared a traditional classroom to a flipped classroom, and analyzed student academic achievement results as well as student perceptions of flipped classrooms.

The flipped classroom provides a starting point for instructors to engage their students in more active learning. Studies have shown that when active learning strategies are employed in a flipped classroom, significant learning occurs and students are generally more pleased with their classroom experience (Berrett, 2013; Love et al., 2013; Wilson, 2013; Wiginton, 2013).

There are significant benefits of a flipped class which include having more time for active learning, student control of time and pace of the content delivery, as well as significant improvement on test scores. Struggles of the flipped class involve student resistance to the changes, students coming unprepared for class, and the time it takes teachers to prepare the lesson videos and active learning classroom activities.

This action research study will focus on the academic achievement results of employing a flipped classroom over the course of two years. It will compare two years of scores in the flipped classroom to the three previous years scores in a traditional setting. This is significant because longitudinal studies in the context of a flipped classroom are lacking. This study will also analyze students' perceptions of a flipped classroom. Next, classroom interventions are discussed.

Intervention

This action research study presents the findings of previous research conducted on a flipped classroom. Implementing a flipped classroom is one way to increase student engagement and maximize time in the classroom with active learning strategies. The majority of instructors see some sort of a gain in student test scores when the flipped classroom is implemented (Wiginton, 2013). The research also suggests that students enjoy the flexibility of a flipped classroom, are more engaged in the content, have increased motivation, enjoy being able to communicate with both the teacher and other students on a daily basis, and enjoy the activities incorporated into the classroom (Berrett, 2013).

There has been little research conducted that explores the impact of a flipped classroom on student achievement over a long period of time. Many studies employ the use of a flipped classroom for a specific unit of study (Brunsell & Horejsi, 2013), a few units of study (Fallis, 2013), or one semester (Love, Hodge, Grandgenett, & Swift, 2013), which gives little time for the instructor to change and improve the design of the class. Changes in available technology allow an instructor to constantly fine-tune this learning environment in order to reach it's maximum potential.

The instructor first implemented a flipped classroom in the fall of 2014. Students were required to watch a tutorial video for each learning objective (learning target) for homework. The next day in class, the learning target was discussed in a mini-lesson and then students worked on their assignments collaboratively or individually while the instructor offered assistance when needed. Although the videos were required, the instructor had no method of ensuring students were actually watching the videos. In the spring of 2015, the instructor used Edpuzzle (www.edpuzzle.com), a free web-based service that allows instructors to assign videos and collect data on student views and give formative assessments throughout the video.

In the fall of 2015 the instructor implemented an active learning strategy by assigning group work. The instructor placed students in collaborative groups and split each assignment into group work and individual work. These collaborative groups changed each unit and were composed of two to four students at various achievement levels. The instructor carefully chose each group in a way to maximize the potential of each student.

In the spring of 2016 the instructor implemented another type of active learning strategy by focusing on the assigned problem sets. The instructor noted that, while some students are motivated by normal classroom factors such as points received for completing their homework, or being held accountable in a group setting, this is not enough of a motivation factor for every student to be actively involved in the learning process. The new intervention to reach these students played to their competitive side but also allowed for those students who did not want to compete to still be actively involved in learning.

Students were required to watch the lesson tutorial videos as normal and each class period started as it usually did with a mini-lesson. The premise for the active learning strategy came from a popular review game in which students compete in teams to complete a problem

set. For this unit of study, the instructor placed each problem set on different colored cards at the front of the room. A challenge problem was also included in each problem set but it was not required for students to complete. After the mini-lesson, students chose one or two cards and began solving them on either a white board or a sheet of paper. As students completed a few problems, they approached the instructor for feedback and this process continued until the problem set was completed.

The instructor used a spreadsheet to give students three points if the problem was answered correctly on the first try, two points if answered correctly on the second try and one point if answered correctly after that. Five points were awarded if students correctly answered the challenge problem. At the end of each day, the leaderboard was updated noting students who received the most points. Students were then evaluated on the same unit test as in prior years. The instructor used the grading scale as seen in Appendix A to give students a score for each learning target. Analysis and interpretation of data are reported in the findings sections of this paper. An action plan for how this research may be utilized by other educators and suggestions for future use of a flipped classroom are also included. The next section of this paper will describe the membership of the action research group.

Membership of the Action Research Group

Demographics

This research study was conducted in an urban school district in the Midwest. There were approximately nine thousand students enrolled in the K-12 school district. This community has an average to high socioeconomic status, with the median household income around \$70,000 and around ninety percent of the population with some college education or higher.

Demographically, the student body was a little under 70% Caucasian with a little over 30% qualifying for free and reduced lunch.

The research specifically occurred in the district's ninth grade school that housed approximately 730 students for the 2015-2016 school year. Specific information about the participants of this study is discussed in the next section.

Participants

Students

All five years of data collected encompass students between the ages of twelve and fifteen with approximately equal populations of both male and female students (See Table 1). All students were selected to be in an advanced level of geometry based on their scores on the Iowa Test of Educational Development and the Iowa Assessment Tests given at the beginning of each school year. Students in this course typically score in the 90th percentile in math but there are some exceptions. The following table shows the demographical data over the five year period.

Table 1

Demographics of Students from 2011-2016 in Advanced Geometry

	2011-2012 Traditional	2012-2013 Traditional	2013-2014 Traditional	2014-2015 Flipped	2015-2016 Flipped
Age Range	12-15 years	13-15 years	13-15 years	13-15 years	14-15 years
Total Students	63	69	94	90	80
Male to Female	32:31	37:32	52:42	44:46	38:42
Special Considerations					Special Education: 2 students

Researcher

The researcher who conducted this action research study was also the classroom teacher. She had been teaching in this same community for five years, all at the ninth grade level. Currently, the researcher is a full-time teacher and also a graduate student at Iowa State University. The researcher is obtaining a Master's Degree of Education in Curriculum and Instructional Technology. She currently has her Bachelor's of Science Degree in Mathematics with a 5-12 Secondary Teaching License and has ten years of teaching experience.

Availability of Technology

The classroom had a whiteboard and projector access to a desktop computer lab containing thirty computers within ten feet of the classroom, and access to two mobile labs with thirty-five laptops. The students were familiar with using technology, especially with word processing and researching. Many students had access to the internet on their mobile phones or handheld devices and most were familiar with the process of watching videos online. Most students also had access to technology and the internet outside of the school day. For students who did not have access, special considerations were made to allow computer access during their study halls. In the next section, the negotiations of the study are discussed.

Negotiations to Be Undertaken

To protect the rights of those involved, the researcher asked the permission of the school principal to conduct this action research project within the classroom and to use data collected from prior years. The principal gave informed consent giving permission to conduct the research and collect and analyze data.

Students and parents were also informed about the project but were not required to give informed consent to participate in the study. The researcher also completed IRB training as a component of the course. The timeline is outlined in the following section.

Timeline

This research project was a longitudinal study conducted over the course of two years in a ninth grade Advanced Geometry classroom. Other data collected for this study spans the course of five years. The steps taken were: study and plan, take action, collect and analyze evidence, and reflect. Further details taken are expressed in Table 2.

Table 2
Timeline and Details of the Action Research Project

Phase	Dates	Details
Phase 1: Study and Plan	January - March	Identified area of focus, developed research questions, reviewed related literature, wrote literature review draft, notified stakeholders
Phase 2: Take Action	March 21 - April 28	Created active learning activities, implemented active learning activities, created surveys, introduction, intervention, timeline, membership, negotiations, revised literature review
Phase 3: Collect and Analyze	January - April	Collected and analyzed data, administered surveys, interpreted and reported findings
Phase 4: Reflect	April 8- April 29	Reflected on the data after the unit test, prepared further study recommendations, completed action research project and presentation, shared with stakeholders

Data Collection

This section will explain how data were collected and analyzed to answer each of the research questions. Multiple forms of data were collected as seen in the triangulation matrix in Table 3. The matrix is organized by each research question addressed in the action research project and the sources used to gather data to answer each question. The first section will detail how data was collected to answer the questions of overall impact of a flipped classroom on student test scores and impact of active learning strategies on student test scores.

Table 3
Data Sources for Research Questions

Research Questions	Data Source 1	Data Source 2	Data Source 3
How will implementing a flipped classroom approach impact overall student test scores on Advanced Geometry concepts?	Student test scores Years 1-3	Student test scores Years 4-5	
How does a flipped classroom, combined with active learning strategies, impact student test scores on Advanced Geometry concepts?	Student test scores Unit 10 Years 1-3	Student test scores Unit 10 Year 4	Student test scores Unit 10 Year 5
What are student perceptions of the flipped classroom and how do they feel it impacted their academic abilities in Advanced Geometry.	Student Survey		

Overall Impact and Impact of Active Learning Strategies on Student Test Scores

Advanced Geometry instructors at this school practice Standards Referenced Grading procedures in which students are graded on a four point scale. The grading scale is shown in Figure 3. The scale was created by the math department at the instructor's school and was based upon Robert Marzano's Complete Scale for grading (Marzano, 2010). The scale is used in each

math and science course in the school with 0 score representing the student making no attempt at the concept and a 4 representing a thorough understanding.

Figure 3



Grading Scale

Grading is subjective and the scores reflect student level of understanding rather than the number of questions correct. In Standards Referenced Grading, students receive a separate grade for each standard as opposed to one grade for a collection of standards as in a typical test (Marzano, 2010).

Test questions were carefully written so instructors can easily gauge the student level of understanding. Questions are typically multi-step and are rarely multiple choice or true/false. To further validate student test scores, the instructors of Advanced Geometry collaborate in order to consistently grade each section across all sections of Advanced Geometry. .

To answer the the questions of impact of a flipped classroom on test scores and impact of active learning strategies on overall test scores, student test score data was collected and organized on a spreadsheet. Data was collected for twenty-five standards which represents four units of study in the second semester. The data were analyzed using quantitative measures such as a two-tailed, two-sample unequal variance test. Data collection for student perceptions for a flipped classroom is described in the next section.

Student Perceptions of a Flipped Classroom

To determine the students' perceived benefits of a flipped classroom on their overall achievement and satisfaction of the course, students were given class time to complete an anonymous survey on Google Forms (See Appendix B) after the first active learning unit. Twenty-three questions were asked using a Likert scale and four open-ended questions were given at the end. Questions asked stemmed from a survey conducted by Dan Barrett (Barrett, 2013) (See Appendix C). Some questions were removed and other questions were added to the survey based on the uniqueness of the course and active learning activities done. Questions topics included perceptions on tutorial videos, homework, and overall class structure. Four open-ended questions were asked which included advantages and disadvantages of a flipped classroom, whether the student would recommend a flipped class to a friend and student opinions about how the flipped class could be improved.

The qualitative data was coded and was analyzed by searching for commonalities among student responses. Geoffrey Mills (2014) explains the process of coding data by first reading through all the data and attaching labels. Next, sort the data according to a common theme in order to break the data into a more manageable form. Finally, revisit each group of data to verify it fits into that theme (Mills, 2014). Appendix D is the table that describes the coded data. The analysis and findings of the data is discussed in the next section.

Data Analysis and Findings

This section presents the findings of the data analysis to address the four research questions presented in this action research project. The findings are organized by each research question.

Results From the Overall Impact of Student Test Scores

The first research question was stated as follows: “How will implementing a flipped classroom approach impact overall student test scores on Advanced Geometry concepts?” To answer this question, the researcher referred to the measures of central tendency for each standard addressed. The researcher first compared test scores from three years of a traditional to two years of a flipped classroom by calculating the mean, standard deviation and running a two-tailed, two-sample unequal variance. According to the t-test results as referenced in Appendix E, the mean test scores were not statistically significant ($p < .05$).

While much of the literature (Berrett, 2013; Love 2013; Wilson, 2013; Wiginton, 2013) found the flipped classroom to offer statistically significant improvements in test scores, this study shows that the flipped class did not show the same results. However, this data may not be significant because of the data collection tool used. Mertler, 2014, states that mean data may not be the most appropriate type measure of central tendency when analyzing data from a Likert-type scale, such as the grading scale used in this course (See Appendix A). Since students are graded on a scale and most grades occur between scores two and four, a score of zero is considered a strong outlier. According to Mertler (2014) in these types of situations the median may be the most appropriate measure.

A chart of the median scores of traditional and flipped classes can be found in Appendix E. Of the twenty-five learning targets, fourteen had equal median scores between the traditional and flipped classes. Of these fourteen equal median scores, six were scores of 4, the highest score possible. Of the remaining eleven scores, nine scores showed a higher median score in favor of the flipped classroom and two scores showed a higher median score in favor of the traditional classroom. The majority of median scores increased from a score of 2.5 to a score of

3. According to the grading scale (See Appendix A), a 2.5 means, a student is developing their knowledge and makes major errors, while a 3 means a student is capable of demonstrating knowledge on the concept and makes minor errors. An increase in scores from 2.5 to 3 shows significant gains in understanding. It is clear from this data that there is significant impact on student test scores when the flipped classroom is employed.

From the personal experience of the instructor, the flipped classroom allows the instructor to be more actively involved in student learning. The instructor typically walked around the classroom helping students through the homework problems they were stuck on. If the instructor saw that multiple students were confused on the same problem, the instructor was able to bring the whole class together as a group and walk them through the problem. Students could also collaborate on a daily basis on their assignment. When the instructor taught traditionally, these things only occurred if there was time left after the lecture. The next section will detail the results of implementing the active learning strategies.

Results of a Flipped Classroom with Active Learning Strategies

Question number two is stated as follows: “How does a flipped classroom, combined with active learning strategies, impact student test scores on Advanced Geometry concepts?” To answer this question, the researcher referred to the measures of central tendency for each standard addressed in Unit 10, the active learning unit. The researcher first compared test scores from three years of a traditional to one year of a flipped classroom without active learning strategies and one year of a flipped classroom with active learning strategies by calculating the mean, standard deviation and running a two-tailed, two-sample unequal variance. According to the t-test results as referenced in Appendix E, a few of the data proved to be statistically

significant in favor of the active learning flipped class but the majority of scores proved not to be statistically significant ($p < .05$).

While much of the literature (Berrett, 2013; Love 2013; Wilson, 2013; Wiginton, 2013) found the flipped classroom to offer statistically significant improvements in test scores, this study shows that the flipped class did not show the same results. However, these data may not be significant because of the data collection tool used. Mertler 2014, states that mean data may not be the most appropriate type measure of central tendency when analyzing data from a Likert-type scale, such as the grading scale used in this course (see Appendix A). Since students are graded on a scale and most grades occur between scores two and four, a score of zero is considered a strong outlier. According to Mertler, 2014, in these types of situations the median may be the most appropriate measure.

Appendix F is a chart that compares the median scores for the traditional classes, flipped classes and active flipped classes for Unit 10, the active learning unit. Of the seven learning targets, three had equal median scores for all three data sets. These were scores of 4, the highest score possible. In the remaining four learning targets, the active flipped class outscored the traditional class scores by a half point every time, which, according to the grading scale (See Appendix A), shows significant learning improvements. The active flipped classes also either outscored (2 learning targets) or was equal to (2 learning targets) the flipped classes.

These data show significant learning occurs with the use of active learning strategies in combination with the flipped classroom. From the personal experience of the educator this result is due to students feeling more motivated to engage in the homework problems. Students were tired of completing problems from the textbook. While completing their assignment, students were able to be mobile by retrieving the cards and seeking instructor feedback. This helped

students focus for longer periods of time. Also, the competition aspect motivated many of the students who were previously not motivated at all. Prior to the first active learning unit, four students were failing the course. All but one of the four students was motivated by the active learning component and saw such significant improvement on their test scores that they were no longer failing the course after the test. Student perceptions of the flipped classroom are detailed in the next section.

Results of Student Perceptions on the Flipped Classroom

Question number three is stated as follows: “What are student perceptions of the flipped classroom and how do they feel it impacted their academic abilities in Advanced Geometry.” The researcher examined data collected from the Student Perceptions Survey. Sixty-eight students participated and the questions and figures for each response can be found in Appendix B. After analyzing the Student Perceptions Survey data, the researcher found some common themes in the student responses.

Lesson Videos

The lesson videos seemed to be a common theme among all student responders. However, students had varying degrees of opinions about the videos. Statements about the tutorial videos all received neutral median scores of “3.” However, students had a lot to say about the tutorial videos during the free response section of the survey. Students seemed to like the video tutorials because it gave them the ability to rewatch them as needed as well as helped them to learn at their own pace:

“I can re-watch the lesson as many times as needed, and go to specific points in the lesson”

“I like being able to go back and revisit the lesson by revisiting the videos instead of having her review it in person. Having that resource available is helpful.”

“Watching the videos at home provides a very focused learning place without distractions of other students.”

Students commented that they did not always watch the tutorial videos which made them get behind. Ten students commented that they disliked not being able to ask questions as they were learning the material:

“I don't watch most of the videos on time because I put it off and feel like I can since i'm learning on my own, and since I don't watch the videos on time I don't understand the mini lesson in class and then once i'm there need it again. I also don't like how i can't ask questions during the video and when i'm supposed to be learning it.”

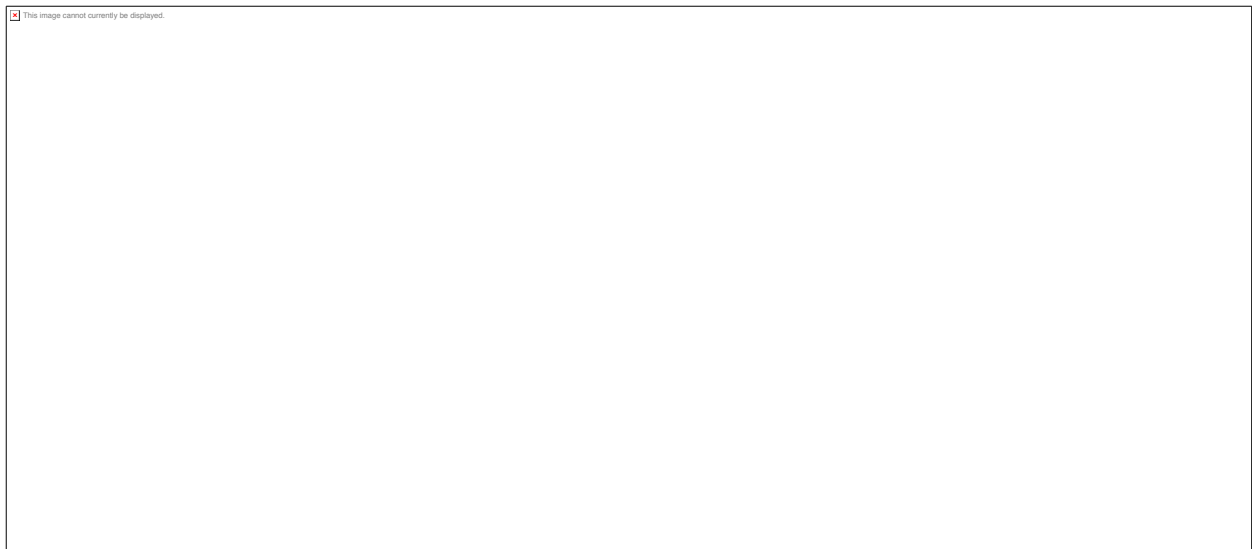
Many students also commented that it was hard to focus on the videos for various reasons such as mistakes on the videos, the videos were too long, or not having a good place to watch the videos. So while many students seemed to see the benefits of the video lessons, shortening the videos and correcting mistakes on the videos can alleviate many of the frustrations associated with them.

Student Self-Pacing

Overwhelmingly, students seemed to like moving at their own pace through the unit as shown in Figure 4. The median for this data was a 5 with thirty-nine students agreeing.

However, when the statement “I would rather have the entire class moving at the same pace through the course” was given, only twenty-two students disagreed with a “1” and thirteen students agreed with a “5.”

Figure 4

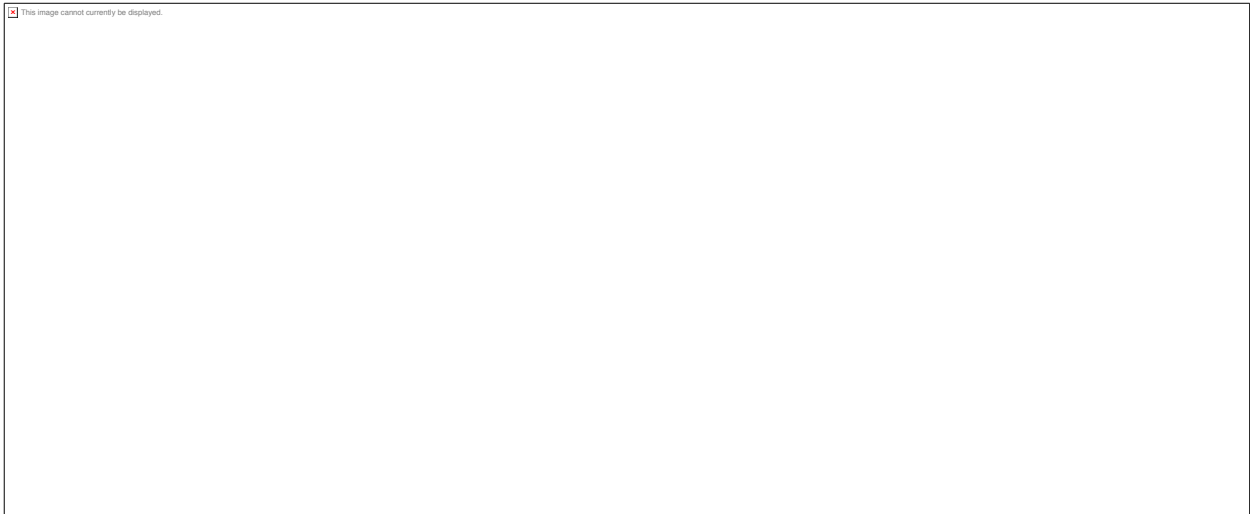


I Like Moving at my Own Pace Through the Unit

When the statement, “I find it difficult to pace myself through the unit,” was given, each score was given approximately the same number of responses as seen in Figure 5. After analyzing the free response data, it became clear that the reason for this discrepancy was issues with the

videos.

Figure 5



I Find it Difficult to Self Pace Myself Through the Unit

“Sometimes the videos are wrong and sometimes I forget the questions I have. But mainly, sometimes answers to the problem seem wrong and I never learn if they were or not. Also, sometimes I fall behind in class because I get stuck on a lesson and there's no time to correct myself or anything.”

“I procrastinate. It's extremely difficult to pace myself and stay on task when it's all up to me. I like having a teacher upfront when I approach a problem or have a question so I don't stock up on questions and can get most of them clarified right on the spot.”

Although students seem to like the ability to pace themselves through the unit, the data shows that students also have a hard time pacing themselves even though a calendar of daily activities is provided to students.

Assignments

Students typically like getting their assignments (problem sets) done in class (median 4). They also found that they are spending less time outside of class than in previous math courses (median 4.5). Nineteen students also commented in the short answer section that they were spending less time outside of class.

Even though students reported that they use their class time to complete their assignments (median 4) students saw that the assignments typically took longer than one class period to complete and had complete it outside of class time.

“I usually don't have enough time to finish my assignment and then I get behind and end up hold off the homework I didn't finish in class because I have to watch the videos every night at home.”

From these data findings, it's clear that if the goal is for students to complete their assignments within the class period, the problem sets need to be short enough for this to be accomplished on a regular basis.

Active Learning

When the statement, “I found the change in unit 10 assignments helped me engage more in my assignments” was presented, students overwhelmingly agreed (median = 4). Students also reported that they disagreed with the statement, “I don't think the change in unit 10 assignments helped me do better on the test” (median = 2). This data, along with the student achievement

data shows that active learning strategies paired with the flipped classroom provides an environment conducive to learning.

Overall Perceptions

Overall, students seemed to find the flipped classroom more engaging than a traditional classroom with a mean score of 4. When asked the question “Would you recommend a flipped classroom to a friend?” forty-two students (62%) answered yes, sixteen students (24%) said no, and nine students (14%) were undecided.

“Yes, because my friends have about a similar attention span as me and may need the low stress, chosen pace environment to thrive.”

“Yes especially if they have a big homework load in other classes because the flipped classroom really cuts down the amount of homework in math class.”

“I would recommend this type of classroom to a friend that has good work ethic. If they are able to always choose to work on homework in class and watch the videos then it will work for them. I think this classroom also works well for people like me, who have low work ethic but pick things up fast and need very little teacher assistance.”

“I would not because it doesn't feel structured enough.”

“I don't know I kind of feel indifferent towards flipped classroom. It just kind of depends on the person.”

These data show that students have somewhat positive attitudes towards the flipped classroom and most would recommend it to a friend. The next section will detail the action plan for this research project.

Action Planning

The conclusions drawn from this study as well as previous research (Berrett, 2013; Love 2013; Wilson, 2013; Wiginton, 2013), suggest that flipping a classroom is a positive instructional choice. Active learning strategies paired with the flipped classroom promote an environment conducive to learning and student achievement improves. Therefore, it is essential to move to the next step in this action research plan.

Reporting Findings

The next step in this action research plan is to report the findings to the stakeholders. The principal, associate principals, parents and students will be informed of the results of this study to support future classrooms that may implement the flipped classroom. The teacher-researcher is currently serving on the district Online Learning Committee and, through this committee, has networked with other professionals interested in flipping their classrooms. The researcher will share the results of the study with other professionals who are interested in flipping their classrooms.

Next steps of the cyclical process

Based on the results of the study, there are additional items the instructor will consider for improving the flipped classroom with active learning strategies. A common theme in the Student Perceptions Survey (See Appendix B) dealt with the instructional videos. Students

repeatedly commented that that the videos were too long and boring. The instructor plans to edit the instructional videos in order to keep them under ten minutes.

The Student Perceptions Survey also revealed that a few students do not think that the flipped classroom is conducive to their learning styles. Future studies on the flipped classroom should involve identifying student learning styles and creating differentiated active learning strategies that cater to the different learning styles of the students. The success of the implementing active learning strategies has led the instructor to research other active learning strategies. Future researchers should study the longitudinal effects of active learning in a flipped classroom as well as the various types of active learning strategies that can be used with a flipped classroom.

Ways to improve the described learning activities as described in the intervention section of this paper have been identified. Over the course of this intervention it was noted by the instructor that, while students were more engaged in the content, many were utilizing outside resources in order to achieve the correct answer the first time and maximize their points. Slader (www.slader.com), is a free web based resource that features millions of solutions to the most popular textbooks in the United States. There, students can find worked out solutions to every problem in their textbook which is where the problem sets stemmed from. While many students were actively solving the problems on their own, others were copying work from Slader in order to maximize their points. Another flaw of the intervention was that students often had to wait in long lines in order to get their answers checked. Since the instructor updated points on a Google spreadsheet as she checked them she was often confined to her desk.

The researcher suggests utilizing Google Forms in order to combat the long lines and and regain the ability to be mobile. The functions of the Google Form will still allow students to

attempt the problem multiple times. The researcher suggests that students attempt the problem twice on the Google form. After the second try students should seek assistance from the instructor. Since Google Forms automatically enters the student answer onto a spreadsheet, the instructor is able to walk around the classroom and any lines to get instructor feedback will be eliminated. It is also suggested that the instructor utilize different resources to create the problem sets.

The researcher will share results with other instructors who are interested in flipping their classroom and has also been asked to speak at a school level staff development about how to effectively flip the classroom. This action research project serves a basis for the instructor to effectively communicate the benefits of a flipped classroom.

Reflections and Suggestions for Implementing a Flipped Classroom

The intention of this action research study was to analyze the effects of the flipped classroom on student achievement in a ninth grade Advanced Geometry classroom. Through this study, I explored active learning strategies which provided a way for me to maximize the quality of time spent in the classroom. I plan to continue to implement active learning strategies in a flipped classroom in the future.

Through the two years of flipping my classroom, I have learned ways to effectively implement it into the classroom. Before school starts my school has an open house night where students can meet their teachers. At the beginning of my second year of flipping, I held two fifteen minute meetings for parents and students in order to explain to both of them my reasons for flipping and what the classroom structure would be. This helped set the tone of the course and allowed parents and students to know what to expect.

I allow a lot of leeway for my students to watch the videos. Students have two checkpoints throughout the unit (usually 3 weeks long) but other than that, they can use their class time as needed. Some students watch the videos at home then use their class time to do assignments but others do the opposite and watch all the videos during class then do their assignments at home. Some students will watch part of the video and then do a few assignment problems, then watch more of the video and then do more assignment problems. This means that students are typically in different places in the unit but have the opportunity to either work ahead or play catch up if they are busy with other activities and/or classes. Students are typically very appreciative of this.

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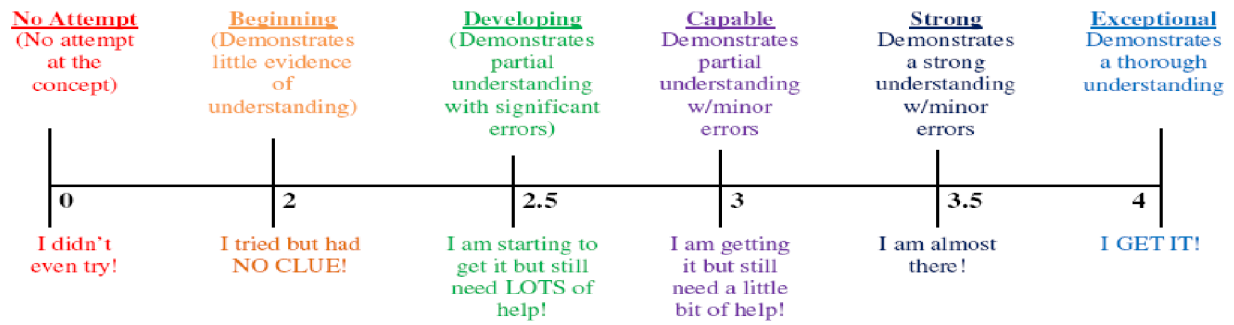
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Appendices

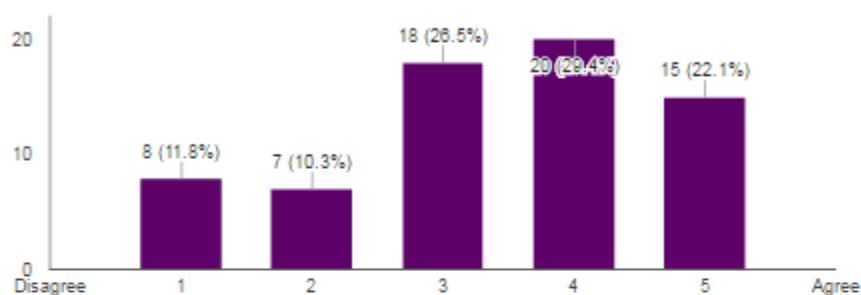
Appendix A: Grading Scale



Appendix B: Student Perceptions Survey and Results

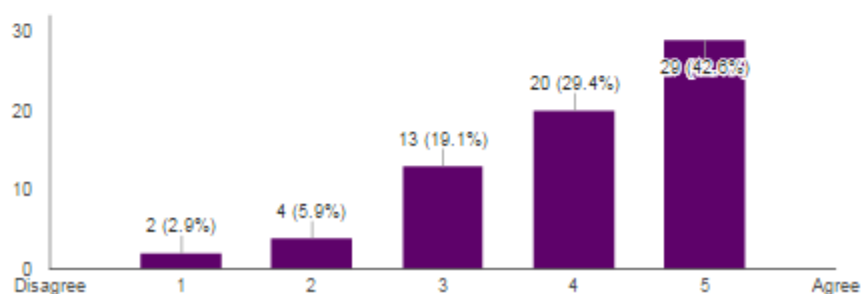
The flipped classroom is more engaging than traditional classroom instruction.

(68 responses)

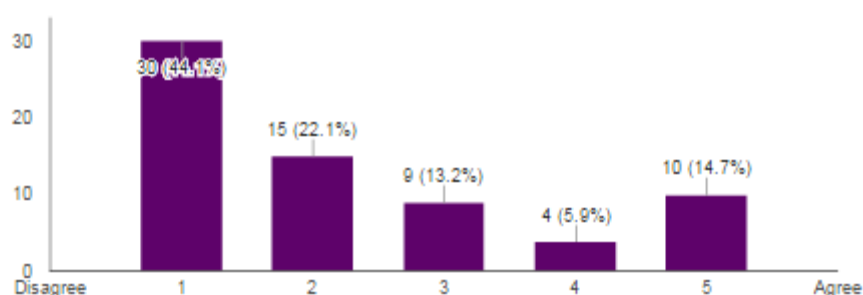


The flipped classroom gives me greater opportunities to work with other students.

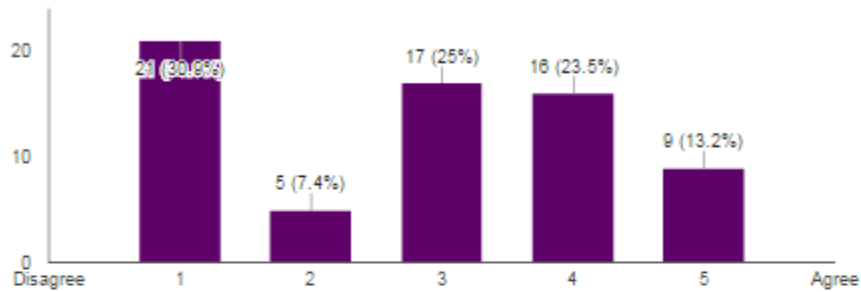
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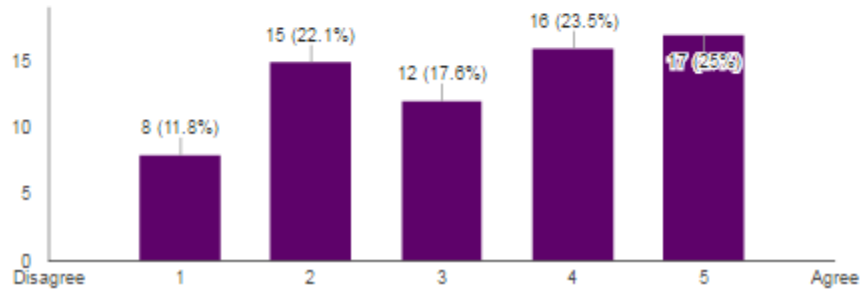
I dislike working on assignments with other students. (68 responses)



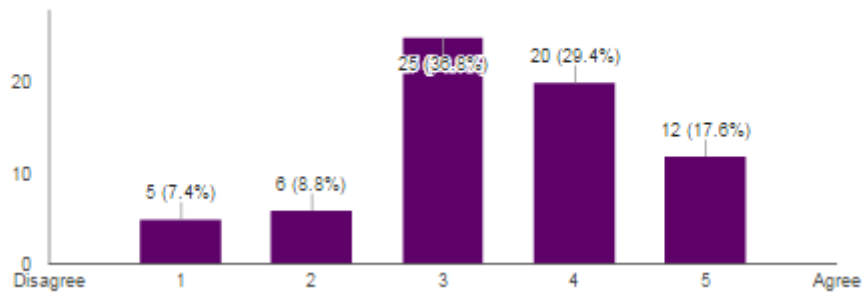
I like watching lessons on videos. (68 responses)



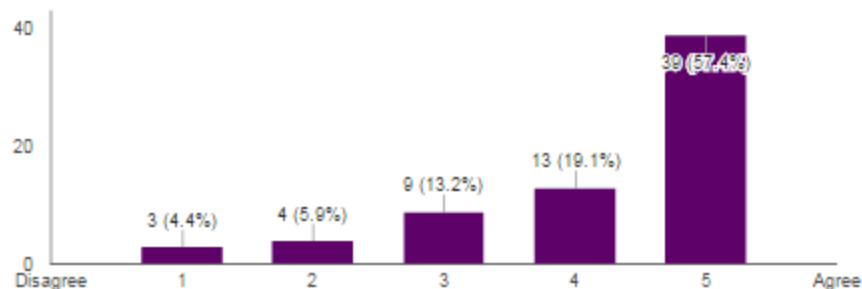
I find it difficult to pay attention to the video lecture. (68 responses)



I find the videos are helpful in the learning process. (68 responses)

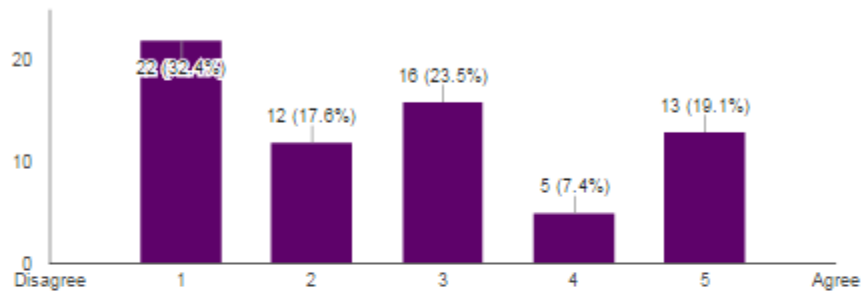


I like moving at my own pace through the unit. (68 responses)

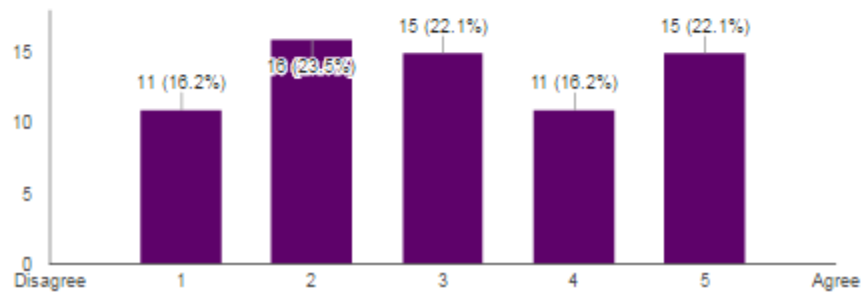


I would rather have the entire class moving at the same pace through the course.

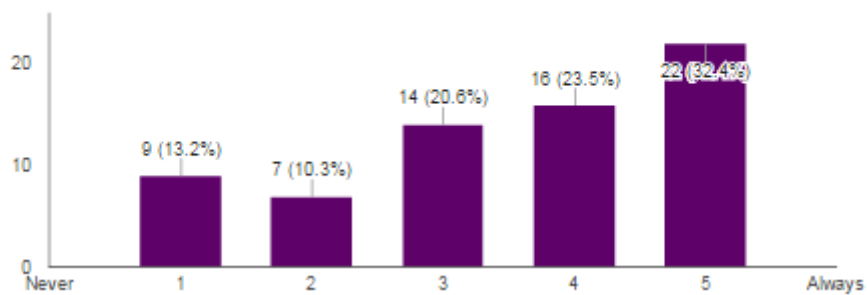
(68 responses)



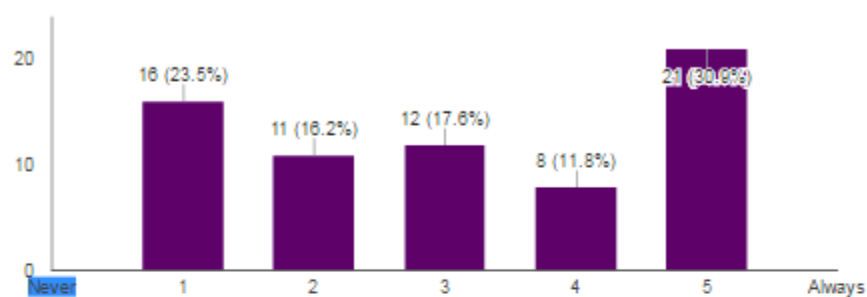
I find it difficult to self pace myself through the unit. (68 responses)



I watch the tutorial videos. (68 responses)

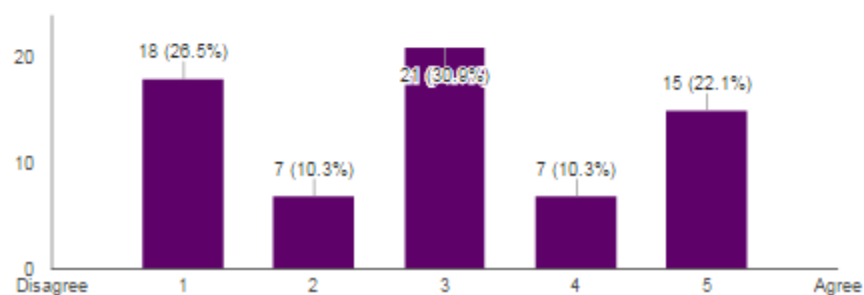


I take notes during the videos (68 responses)

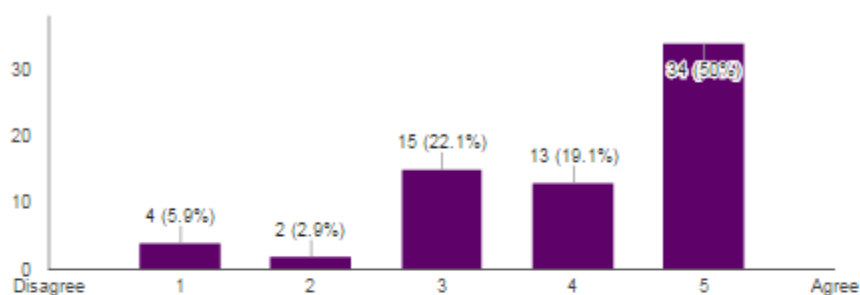


I would rather do my assignment at home and hear the teacher lecture in person.

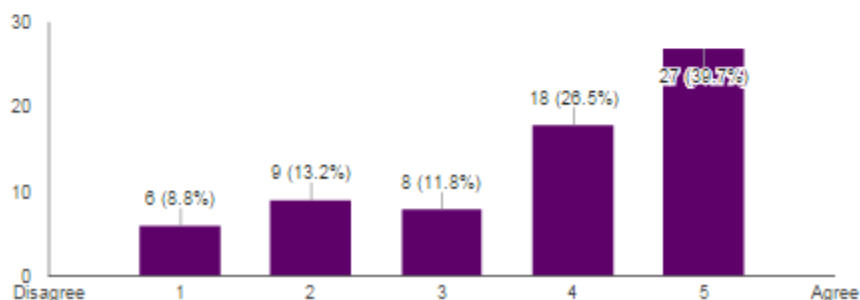
(68 responses)



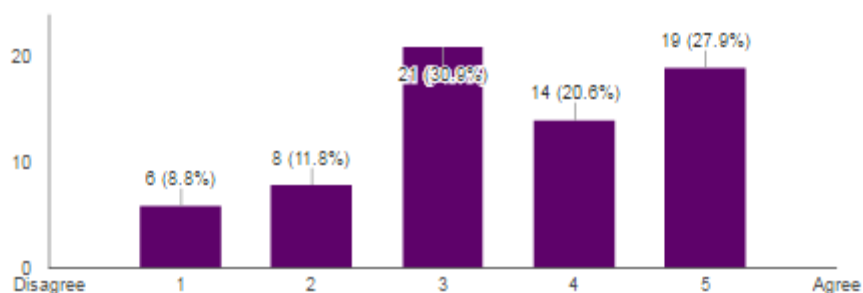
I like doing my assignment in class. (68 responses)



I find the mini-lesson at the beginning of each class helpful. (68 responses)

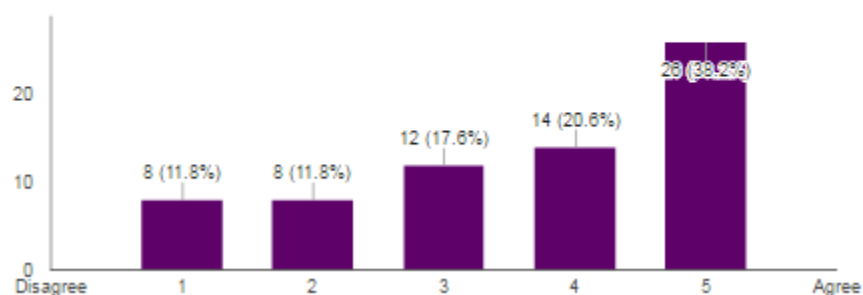


I am spending less time outside of class on Geometry than my other classes. (68 responses)



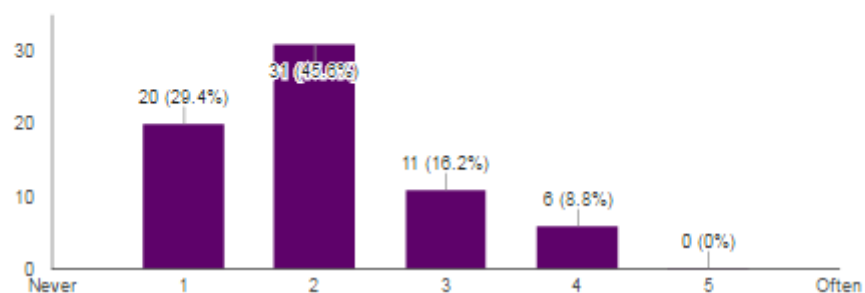
I am spending less time outside of class on Geometry than in my other previous math courses.

(68 responses)

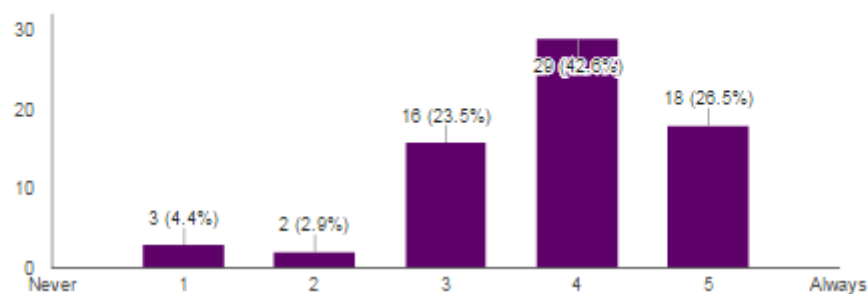


I use outside resources to copy assignment problems without actually doing them on my own.

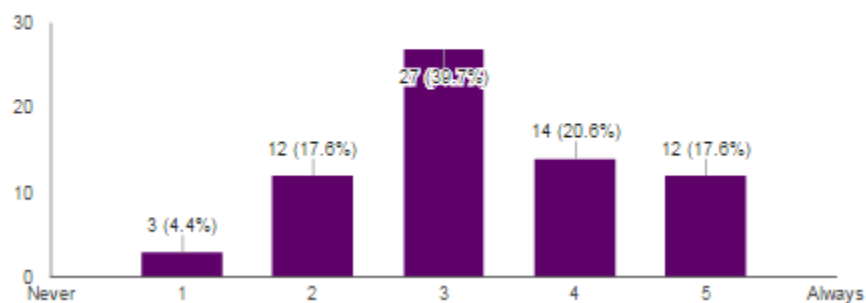
(68 responses)



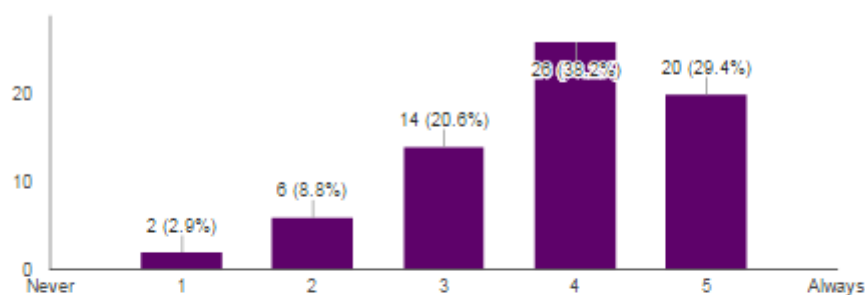
I find assignment problems are helpful in the learning process. (68 responses)



Assignments are too long for me to complete in class. (68 responses)

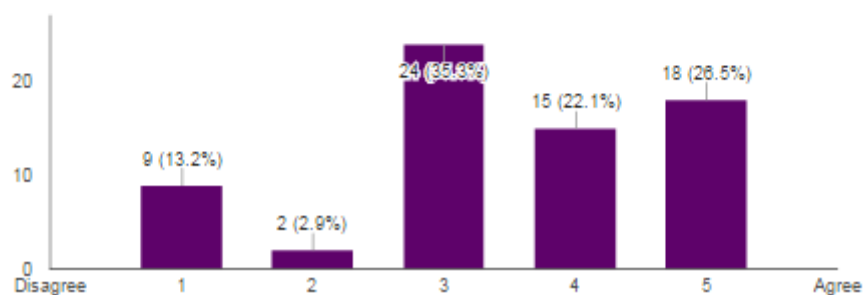


I use class time to complete my assignments. (68 responses)



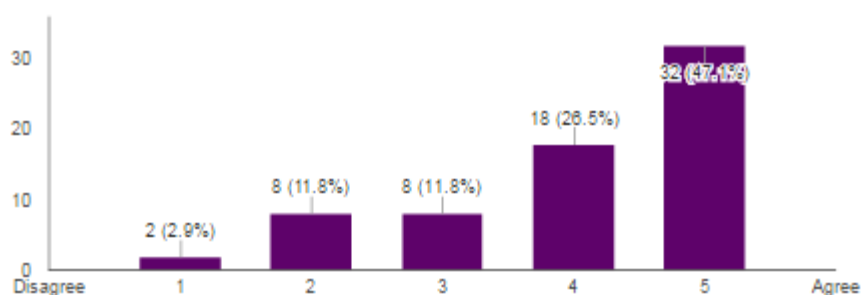
Overall, I think the flipped classroom concept helped me learn the Geometry concepts better

(68 responses)



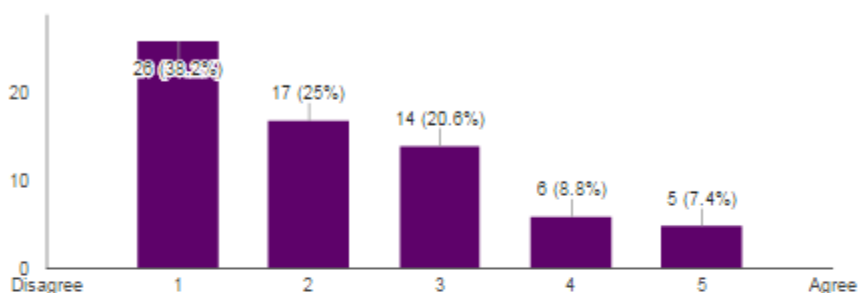
I found the change in unit 10 and unit 11 assignments helped me engage more in my assignments.

(68 responses)



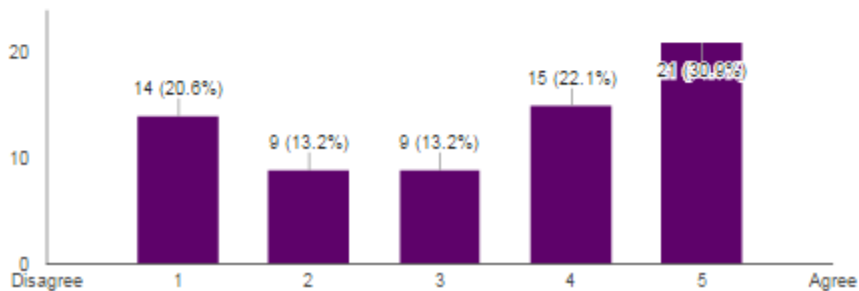
I don't think the change in unit 10 assignments helped me do better on the test.

(68 responses)

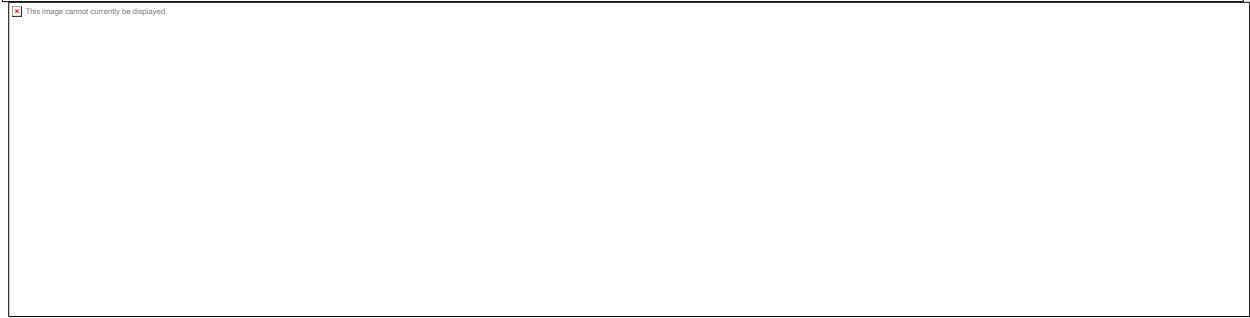


I enjoy completing my assignment problems on the cards instead of in the textbook.

(68 responses)



Appendix C: Berrett's Student Perceptions Survey



Appendix D: Coded Qualitative Data

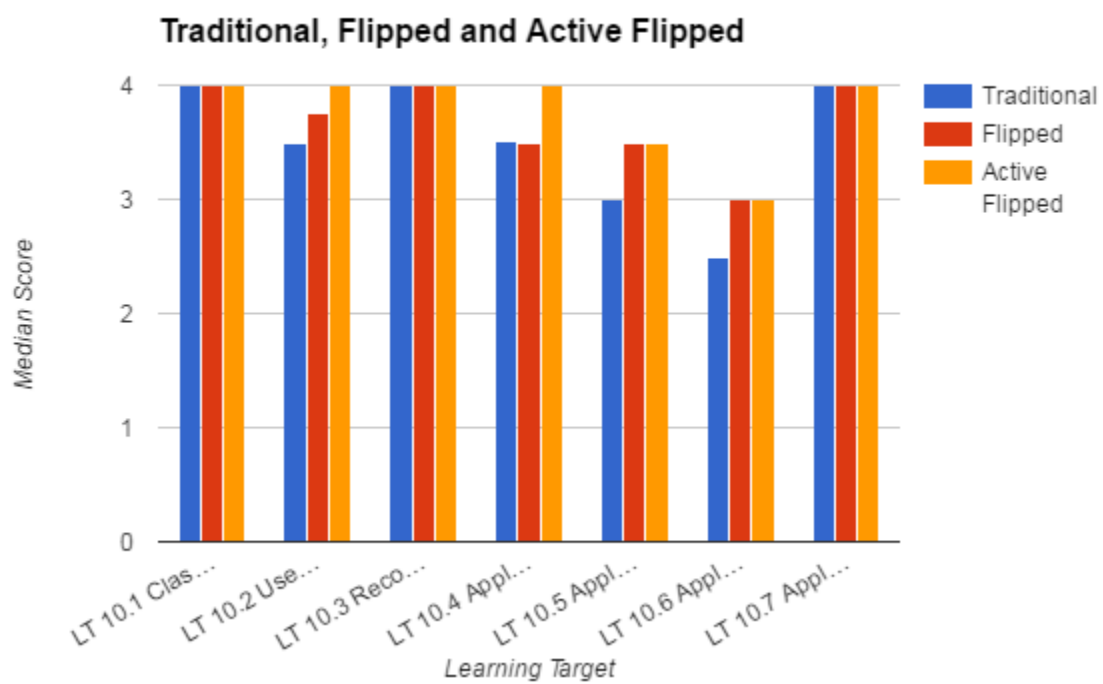
Comments and Frequency of Comments							
Theme	Comment 1	Comment 2	Comment 3	Comment 4	Comment 5	Comment 6	Comment 7
Lesson Videos	Can rewatch videos (8)	Can catch up when absent (1)	Cannot ask questions (10)	mistakes (3)			
Self Pacing/Class Structure	Less time outside of class (21)	Teacher helps more (23)	Work with other students (14)	Work at your own pace (12)	Hard to stay on task (6)	Easy to fall behind (4)	Hard to pace yourself (4)
Assignments	Not enough class time (5)						
Overall Perceptions	More engaging (1)	Less stress (3)	Responsible for learning (2)	Learn better (4)			
Improvements	fewer assignment questions (7)	nothing (12)	Extra mini-lessons (4)	More structure (7)			
Recommend Flipped Classroom	yes (42)	no (16)	Maybe/IDK (8)				

Appendix E: Student Traditional and Flipped Mean and Median Test Scores

	Traditional Classroom				Flipped Classroom				
Learning Target	Mean	Median	Mode	Standard Deviation	Mean	Median	Mode	Standard Deviation	T-Test (p<=.05)
LT 7.1	3.46	3.50	4.00	0.57	3.53	4.00	4.00	0.61	0.30
LT 7.2	3.64	4.00	4.00	0.45	3.61	4.00	4.00	0.51	0.50
LT 7.3	3.73	4.00	4.00	0.40	3.62	4.00	4.00	0.48	0.01
LT 7.4	3.36	3.50	4.00	0.67	3.26	3.00	4.00	0.76	0.18
LT 7.5	3.30	3.50	3.00	0.57	3.36	3.50	4.00	0.58	0.31
LT 7.6	3.37	3.5	4	0.64	3.35	3.5	4	0.68	0.82
LT 8.1	2.98	3	3	0.67	3.00	3	4	0.84	0.84
LT 8.2	3.09	3	3	0.72	3.11	3	3	0.72	0.75
LT 8.3	3.27	3	4	0.85	3.25	3	4	0.79	0.83
LT 8.4	3.52	4	4	0.80	3.52	4	4	0.80	1.00
LT 8.5	3.21	3.5	4	0.87	3.28	4	4	1.01	0.48
LT 8.6	3.26	4	4	0.99	2.95	3	4	1.11	0.01
LT 8.7	2.62	3	3	1.13	2.61	3	3	1.27	0.98
LT 9.1	2.81	2.5	2.5	0.68	2.92	3	2.5	0.75	0.15
LT 9.2	3.30	3	4	0.71	3.24	3	4	0.68	0.42
LT 9.3	2.73	2.5	2.5	0.62	2.75	2.5	2.5	0.62	0.78
LT 9.4	3.16	3	3	0.71	3.17	3	3	0.67	0.90
LT 9.5	3.28	3	4	0.66	3.37	3.5	4	0.67	0.16
LT 10.1	3.68	4	4	0.47	3.67	4	4	0.52	0.83
LT 10.2	3.51	3.5	4	0.58	3.55	4	4	0.55	0.54
LT 10.3	3.85	4	4	0.33	3.75	4	4	0.37	0.01
LT 10.4	3.44	3.5	4	0.65	3.54	4	4	0.67	0.13

LT 10.5	3.25	3	4	0.73	3.36	3.5	4	0.69	0.16
LT 10.6	2.73	2.5	2.5	0.78	2.82	3	2.5	0.80	0.27
LT 10.7	3.33	3.5	4	0.91	3.63	4	4	0.63	0.00

Appendix F: Median Test Scores for Traditional, Flipped and Flipped Active



Appendix G: Literature Review Matrix

	Love, Hodge, Grandenett, and Swift (2013)	Fallis, Wington, (2013)	Cargile & Hartness, (2014)	Gilboy, Heinrichs, & Pazzaglia, (2015)	Chen, Wang, & Chen, (2014)	Abeysekera, Dawson, (2014)	Bernett, Brame, (2012)	Brunsell	Flipped Learning Network (2014)	Freeman, Schiller, (2012)	Gaughan, (2014)	Hawks, (2014)	Kong, (2014)	Lowell, & Verieger, (2013)	Mangan, (2013)	McLaughlin, Roth, Giatt, Gharibolnarehe, Davidson, Griffin, Mumper, (2014)	Roehl, Reddy, & Shannon, (2013)
Compare traditional lecture to flipped style	x	x							x	x	x	x		x		x	
Online Learning Environments/ analyze based on theory			x			x							x				
Student perceptions of flipped learning				x	x	x	x				x						
Cross-sectional or longitudinal			x		x			x			x					x	
Control and Experimental	x	x						x									
Sample of a population			x	x	x	x		x		x	x	x		x		x	
Fully Flipped	x	x	x	x	x		x	x	x	x	x	x	x	x		x	
Partially Flipped			x														
Higher ed	x		x	x	x	x	x		x	x	x	x	x	x		x	
secondary	x	x	x										x				
Pretest	x	x											x	x			
Common Assessments	x	x					x		x	x							
Survey	x		x	x	x	x	x				x	x	x			x	
Interviews	x	x	x		x												
Post-test	x	x											x	x			
Quantitative	x	x	x		x	x	x	x	x			x	x			x	
Qualitative		x	x	x	x	x	x	x	x	x	x	x	x	x		x	